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Online Giovanni Workshop

Chlorophyll variability along the Louisiana-Texas coast from satellite wind and ocean color data

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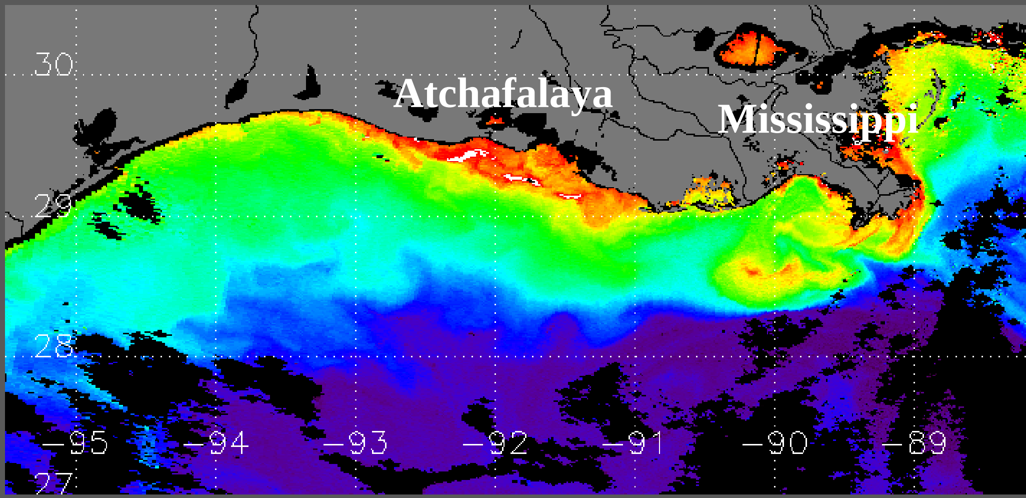
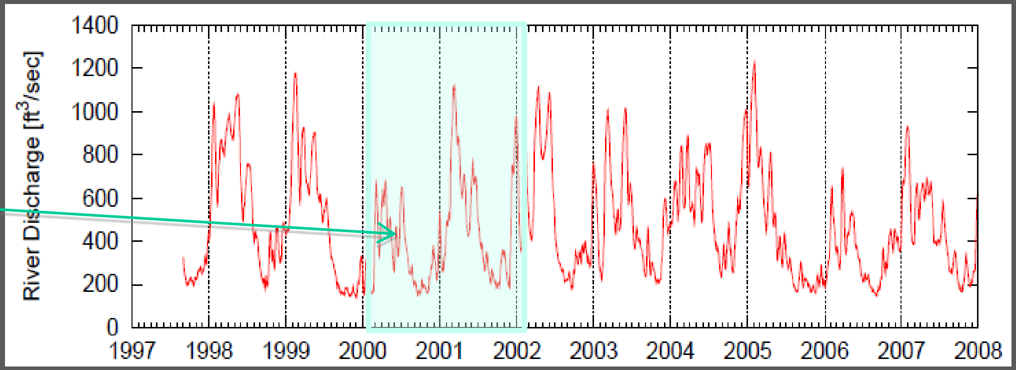
Objectives

•Examine SeaWiFS derived chlorophyll a (Chl) distribution in relation to wind forcing using QuikSCAT satellite data in a large river-dominated coastal margin



•Assess variability in Chl distribution (using Giovanni data) under two river discharge regimes



•Use 10-year time series SeaWiFS Chl data to characterize its temporal variance by identifying dominant frequencies and examining their interannual variability

Mississippi River Coastal Margin

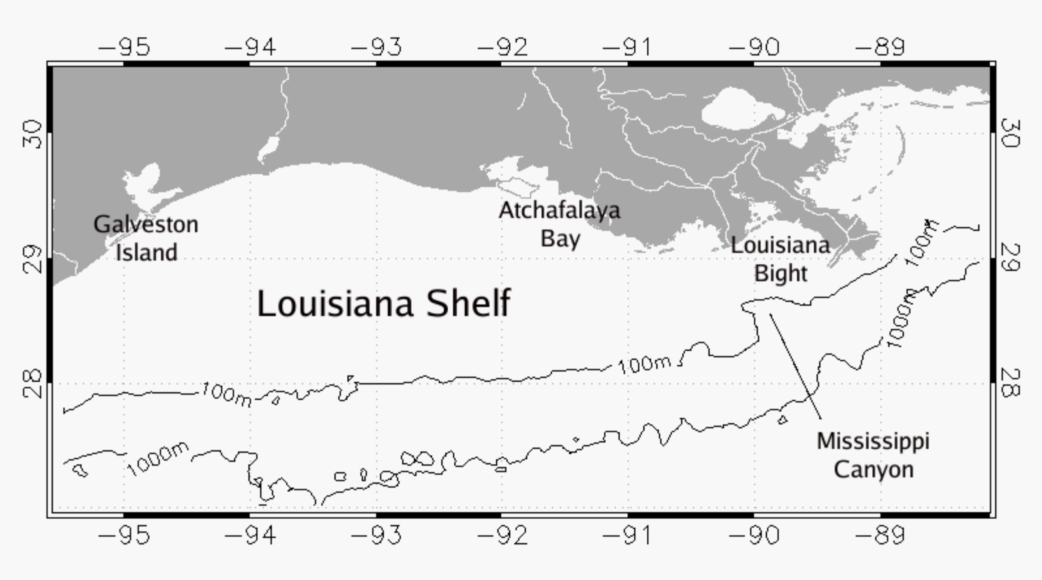
- 2nd largest drainage basin
- 7th in sediment and river discharge

- Discharge from the Mississippi and Atchafalaya Rivers strongly influences bio-geochemical properties

- Highly productive region

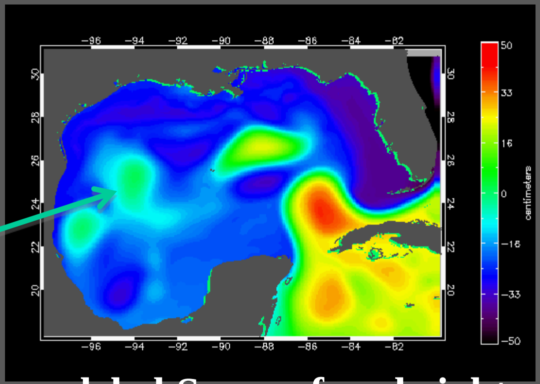
Major issues

- Water quality
- Eutrophication
- algal blooms
- Hypoxia
- Storms and hurricanes



Northern Gulf of Mexico (NGOM)

•Upper circulation in the NGOM is strongly influenced by winds and Loop Current generated eddies

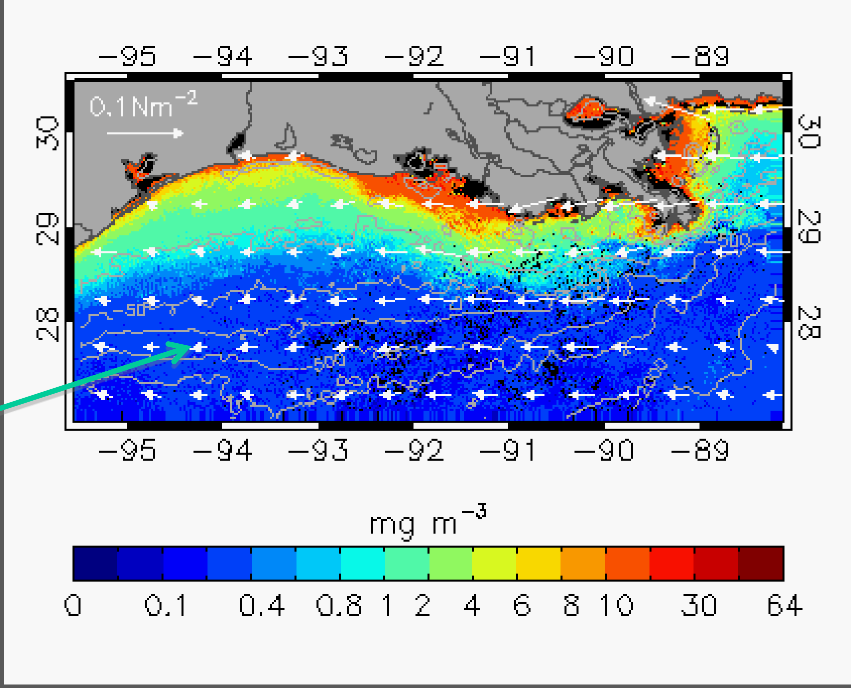


modeled Sea surface height

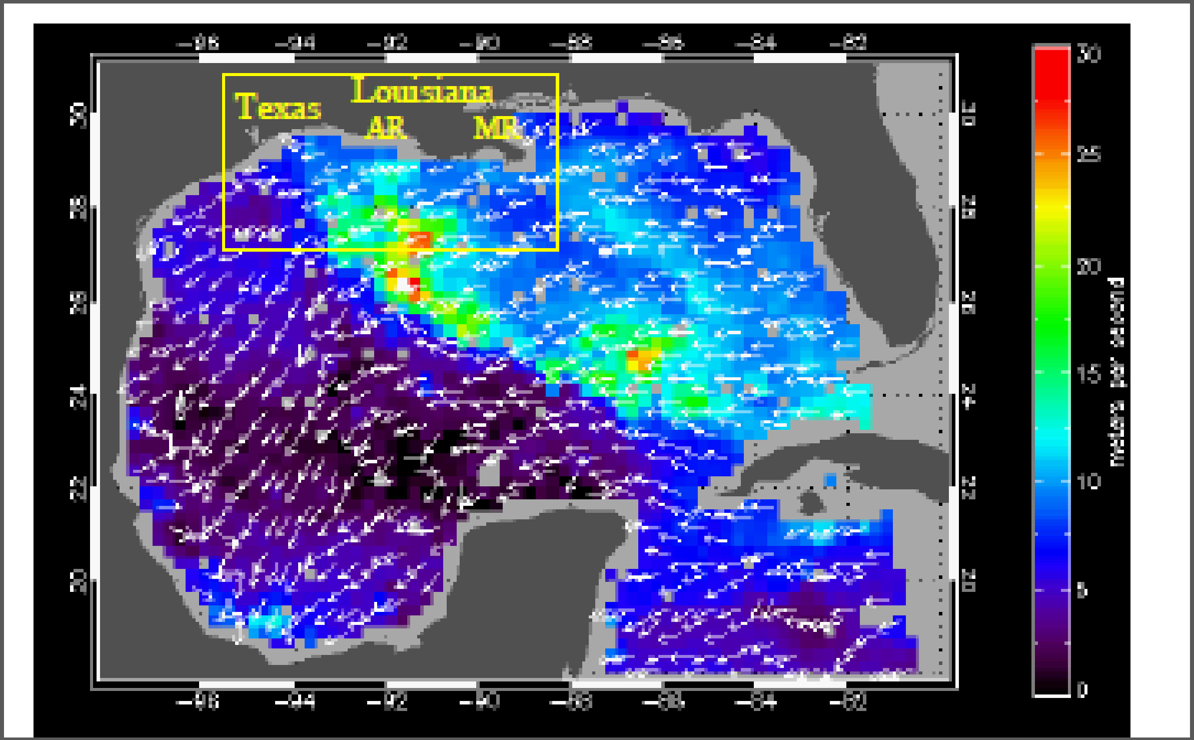
•During fall, winter and spring, easterly/southeasterly winds generate westward flow along the Louisiana coast

•During summer, there is a reversal and upcoast flow of coastal currents

•These currents influence the distri-bution of freshwater, nutrients and productivity in the shelf waters



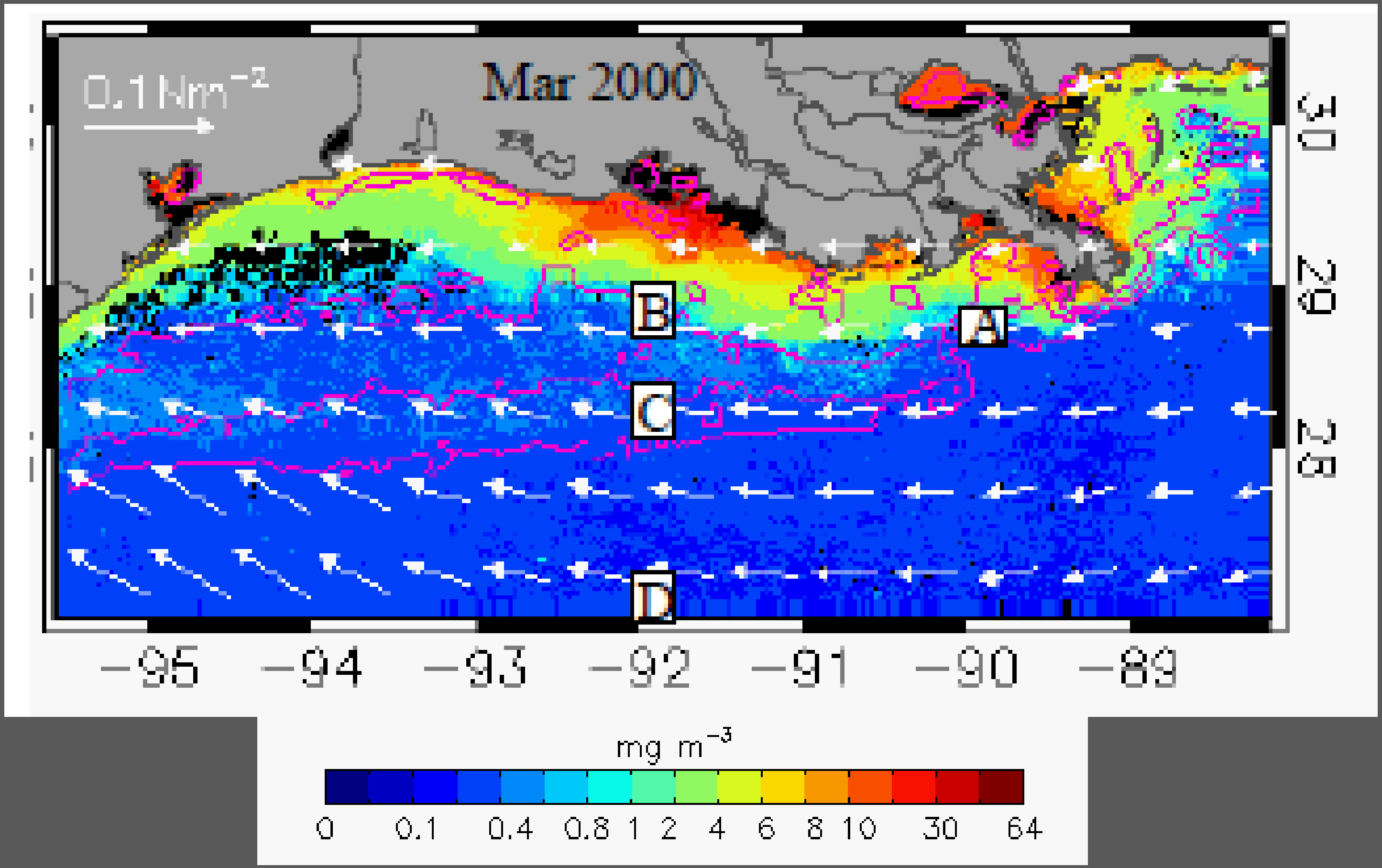
Data



•QuikSCAT satellite wind data products were obtained from NASA JPL and processed for the Gulf (http://gulf-coast.lsu.edu)

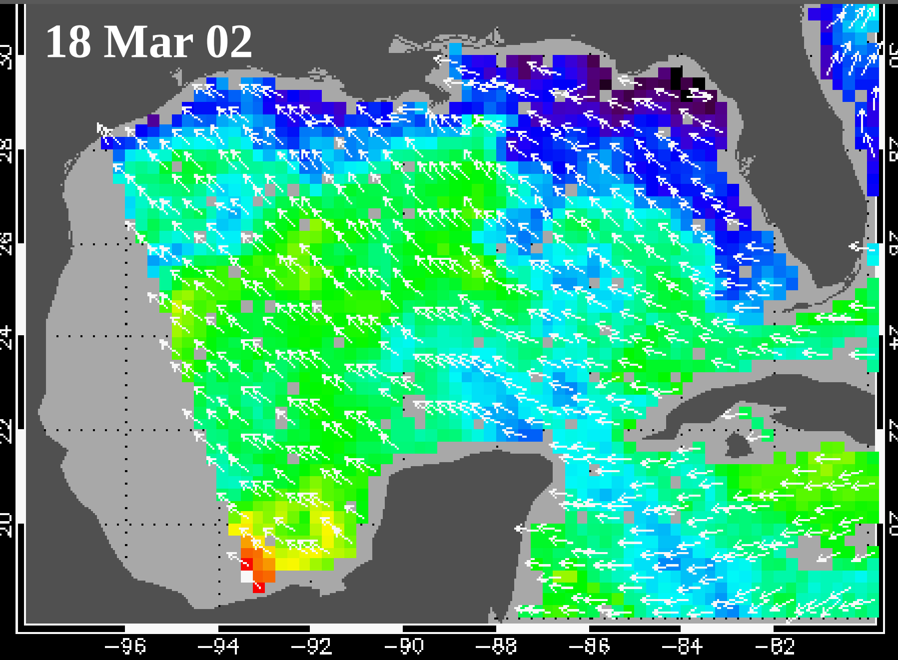
•The 10-m scatterometer winds were converted to wind stress using the drag coefficient algorithm from Large and Pond 1981

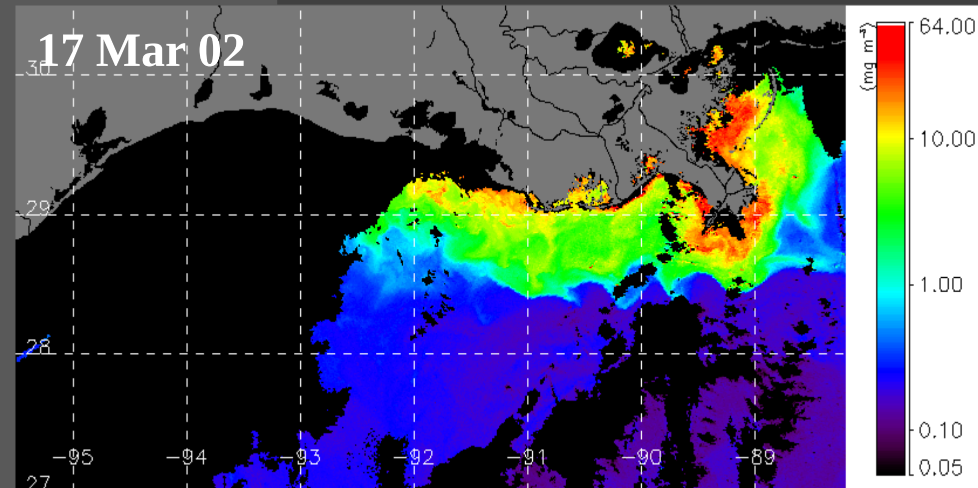
QuikSCAT winds superimposed on Chl (monthly)



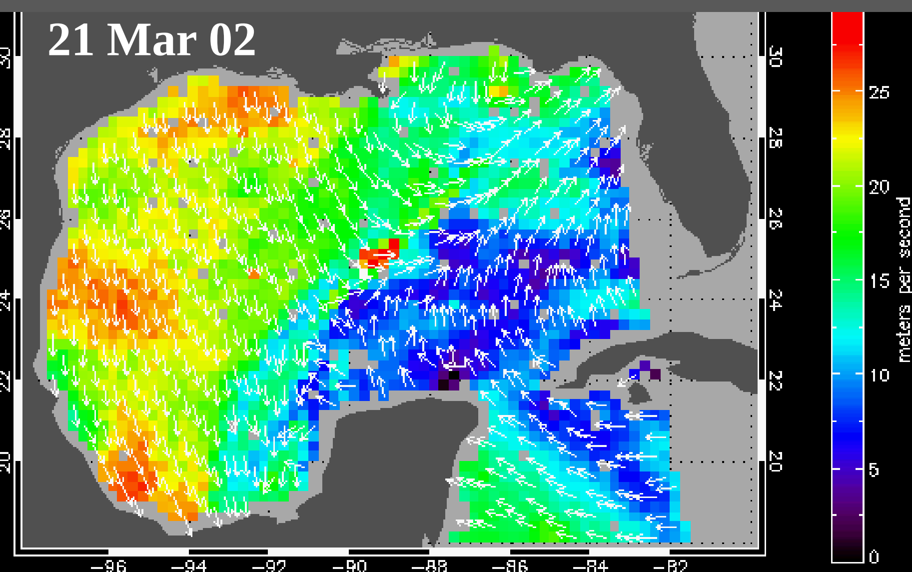
- An example of mean QuikSCAT derived wind stress vectors (N m^{-2}) superimposed on SeaWiFS Chl (mg m^{-3}) for March 2000
- A, B, C and D denote locations for which time series Chl data were obtained from Giovanni

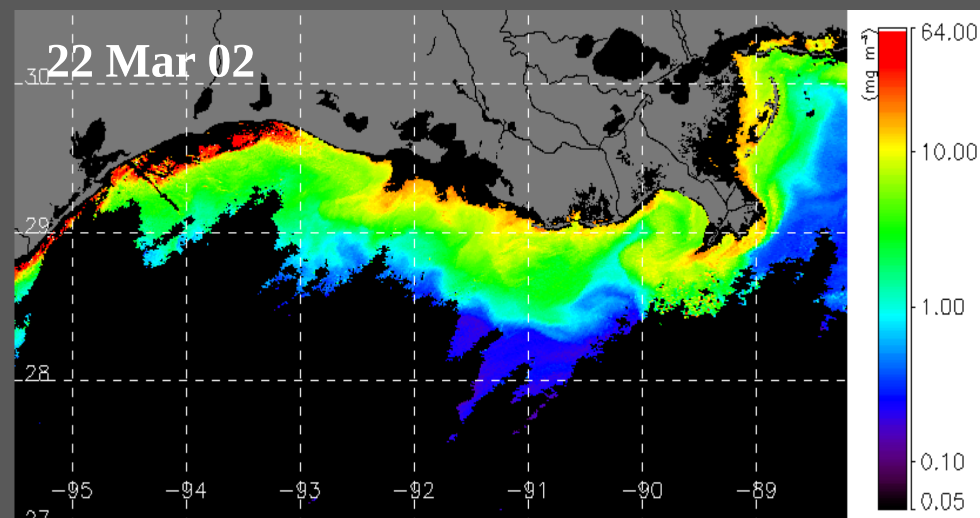
Chl dynamics during frontal passage





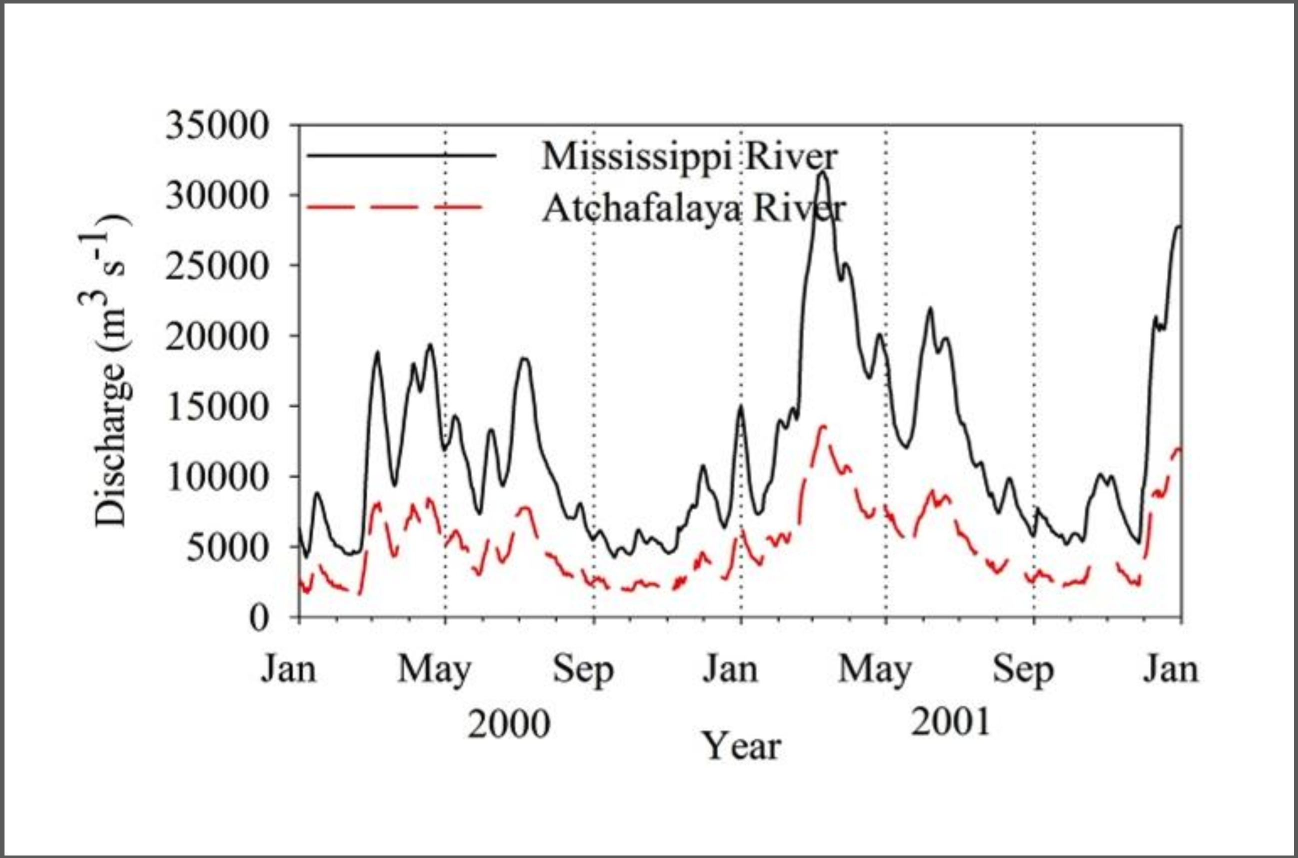
QuikSCAT winds





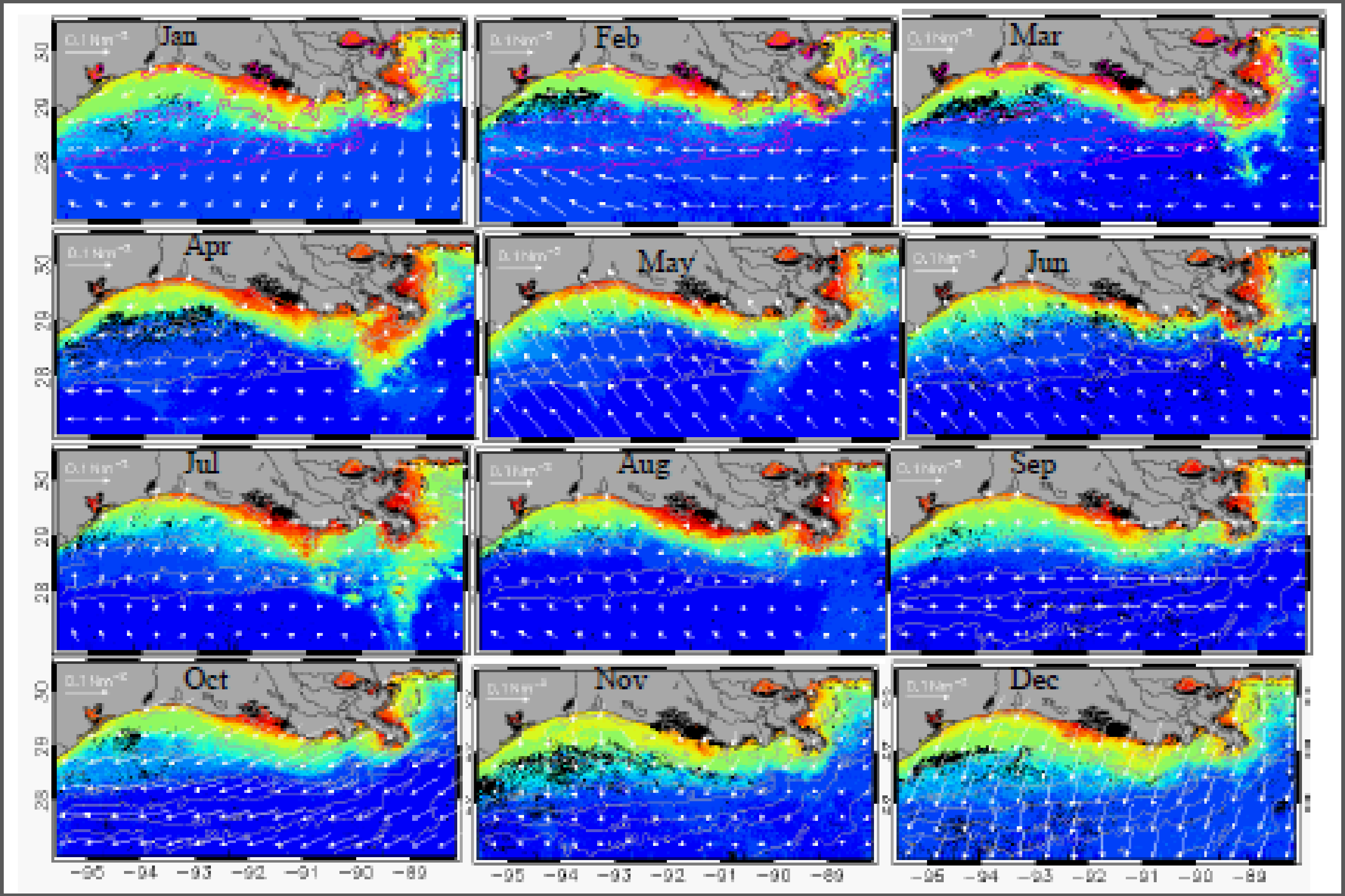
SeaWiFS Chl before and after a frontal passage in March 2002 (clouds masked in black)

Seasonal variability in Chl and river discharge



- River discharge (m^3 s^{-1}) from Jan 2000 to Dec 2001 obtained from Corps of Engineers gauge stations
- 2000 - was low flow river discharge year
- 2001 – normal discharge year

Monthly QuikSCAT wind stress superimposed on SeaWiFS Chl

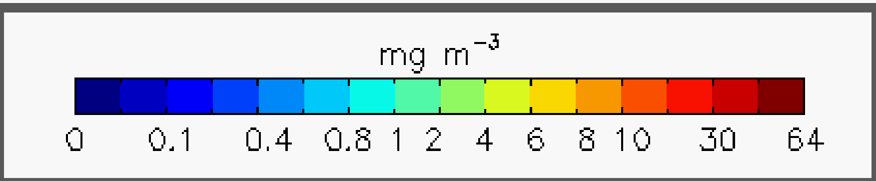


winter

spring

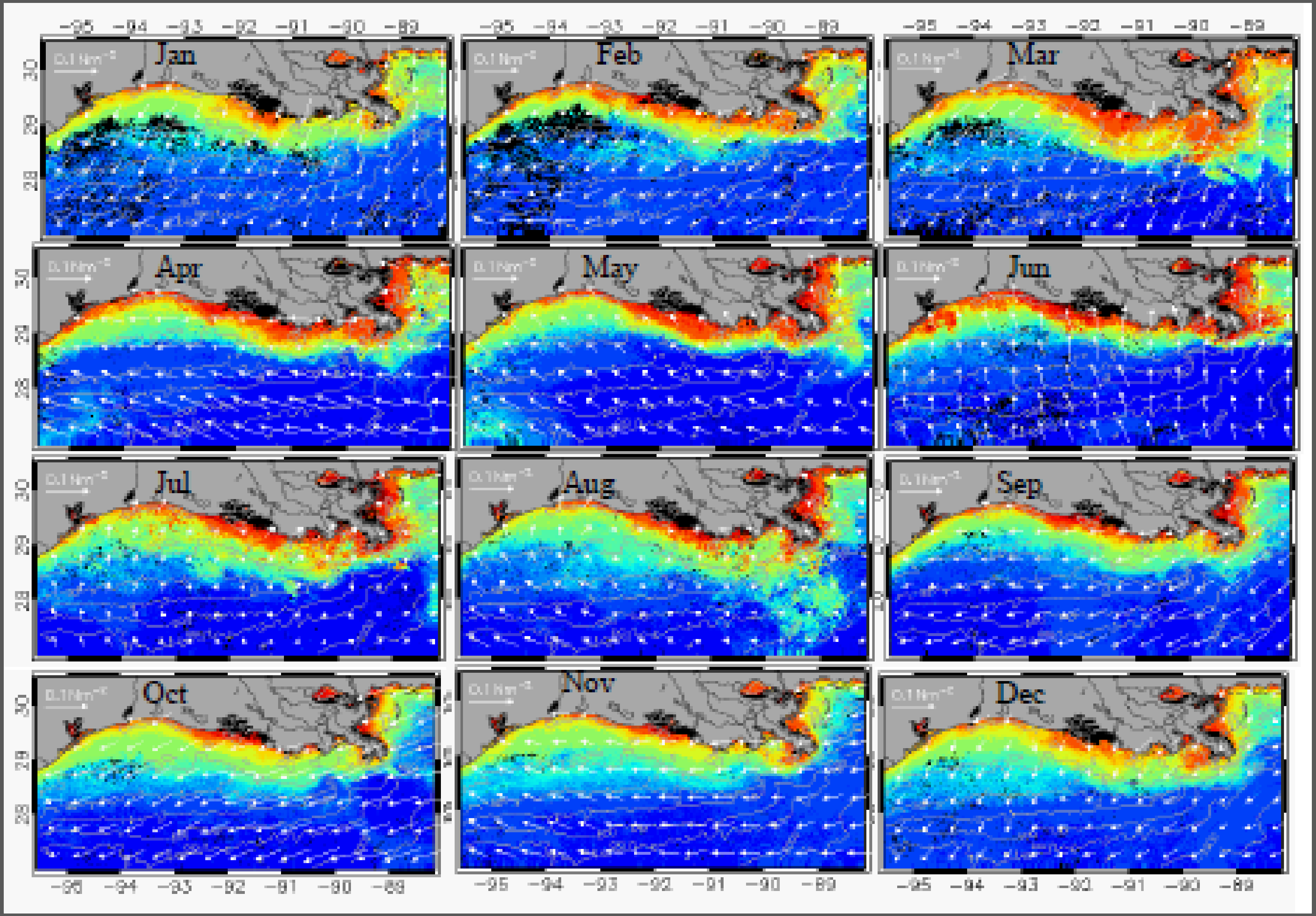
summer

fall



2000- low flow year

Comparison to a normal discharge year



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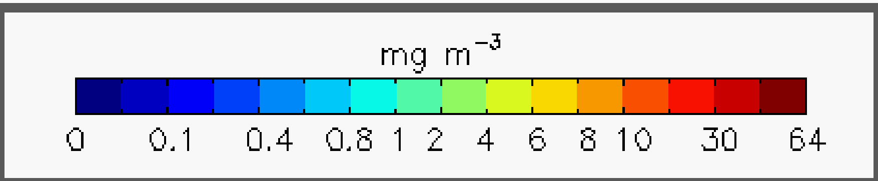
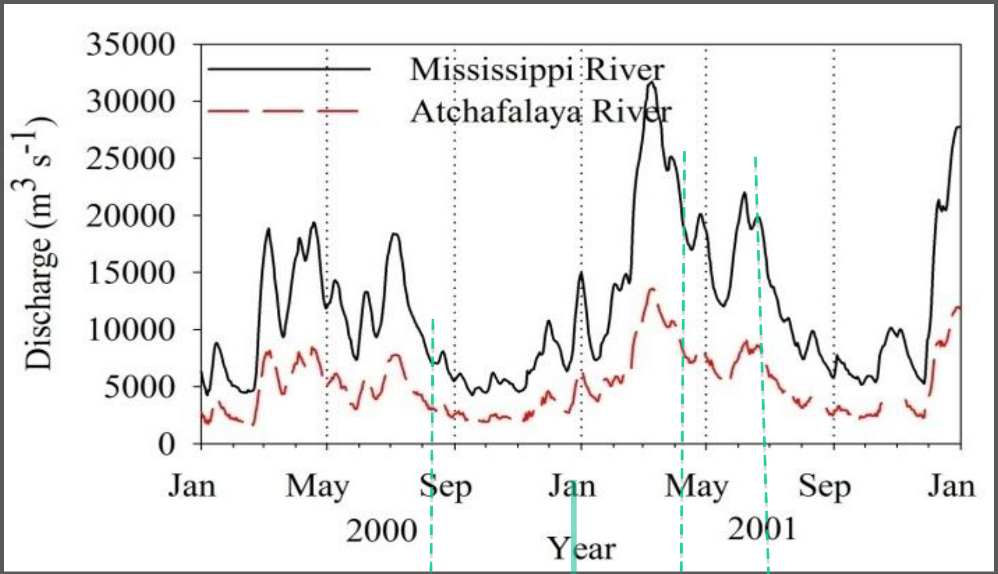
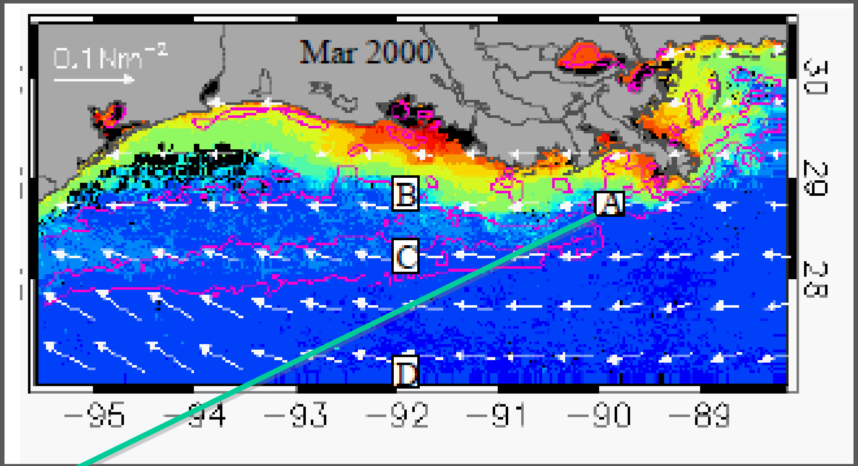


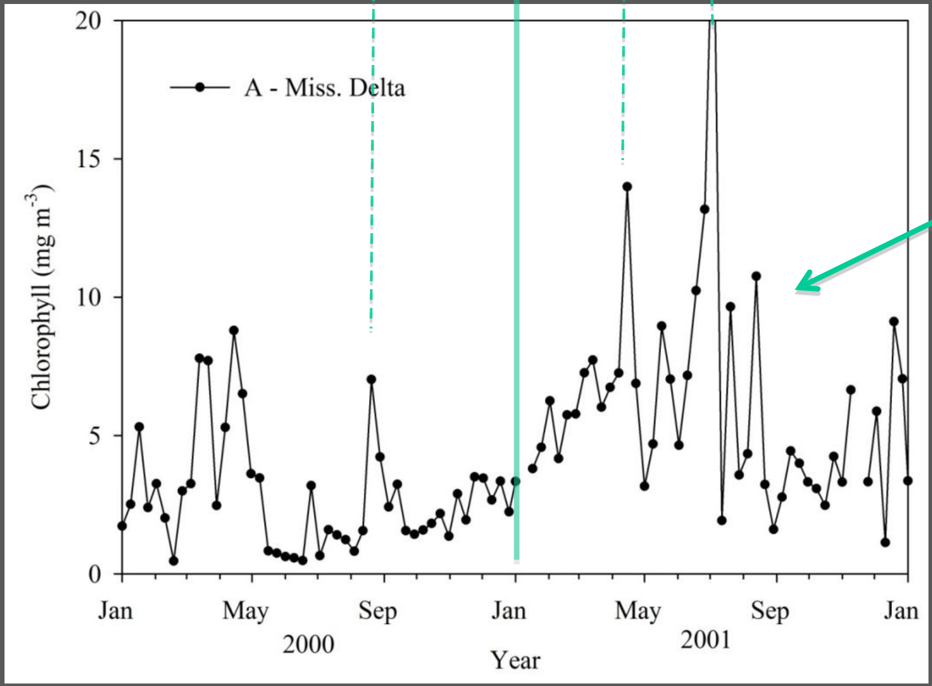
2001- normal flow year

Chl variability west of the Mississippi River delta



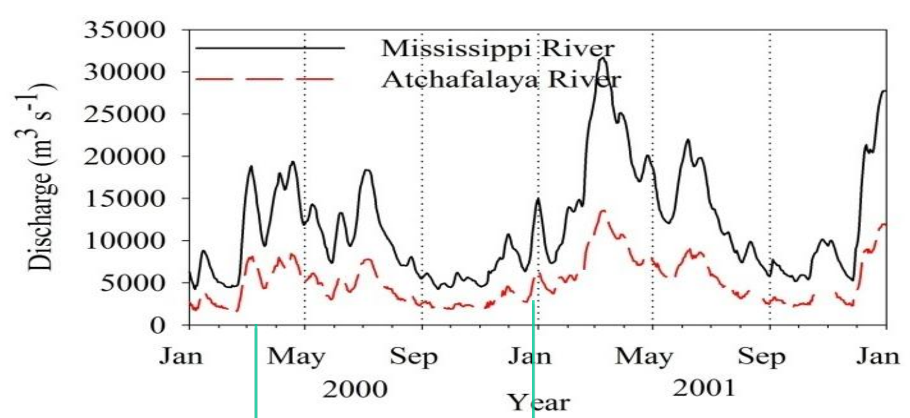
- Discharge from the Mississippi and Atchafalaya Rivers

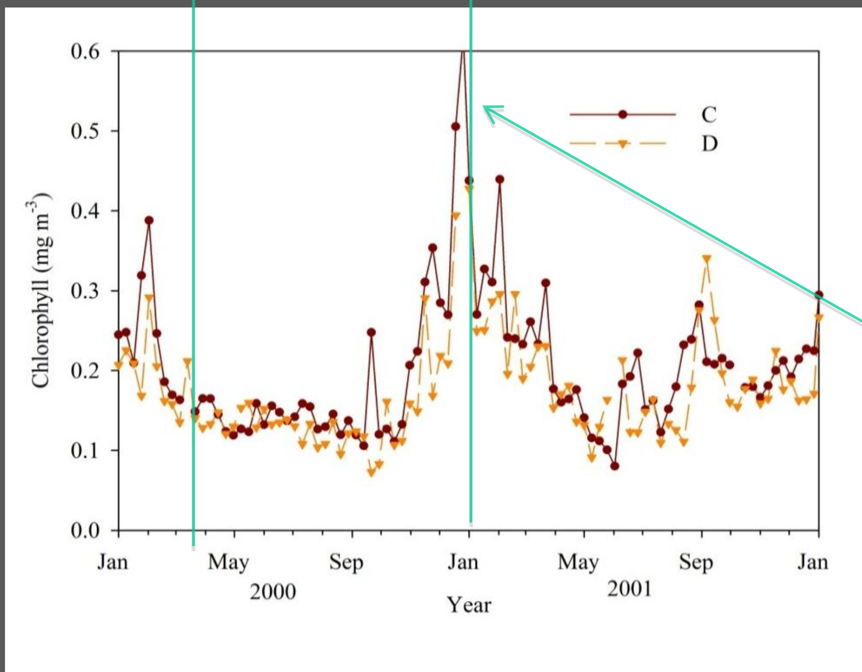


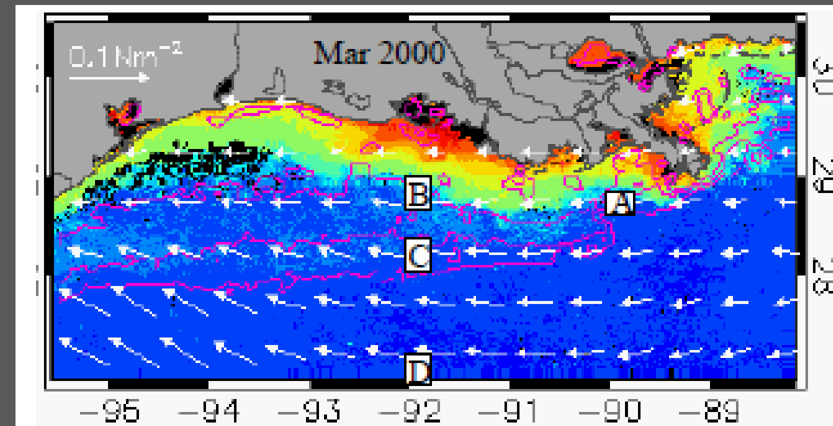


- Time-series of weekly SeaWiFS Chl over an ~20 km^2 area at A from Jan 2000 to Dec 2001

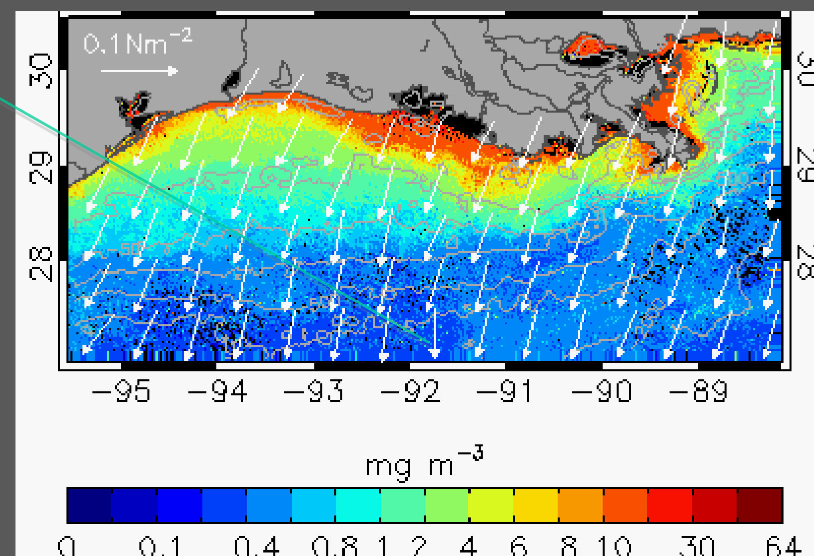
Chl variability off the Atchafalaya







March 2000



Time-series of weekly SeaWiFS Chl over an ~20 km² area at locations C and D off the Atchafalaya delta

Dec 2000

Seasonal wind patterns and Chl distribution

- Easterly winds in April restrict plume waters with elevated Chl to inner shelf waters

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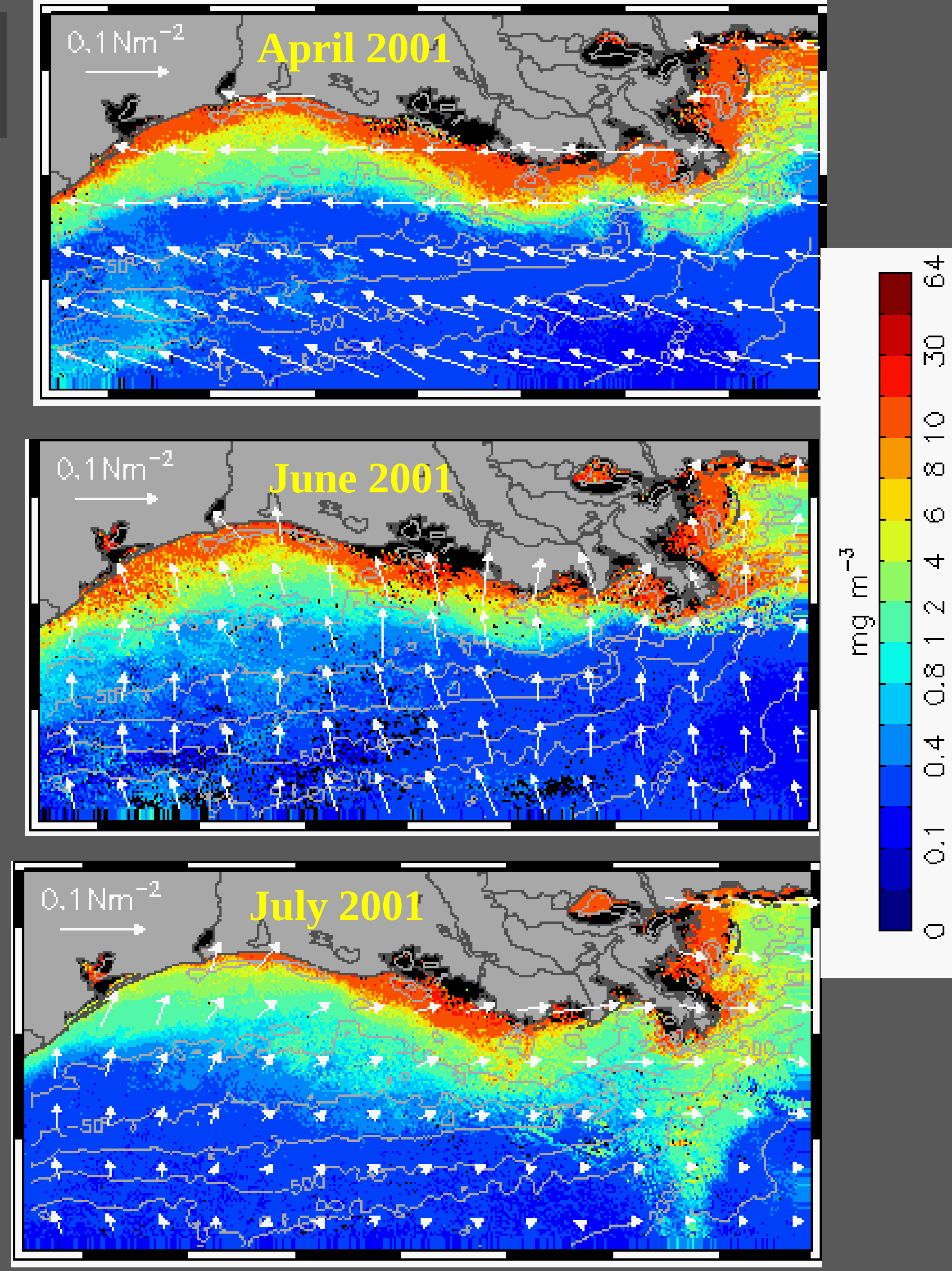
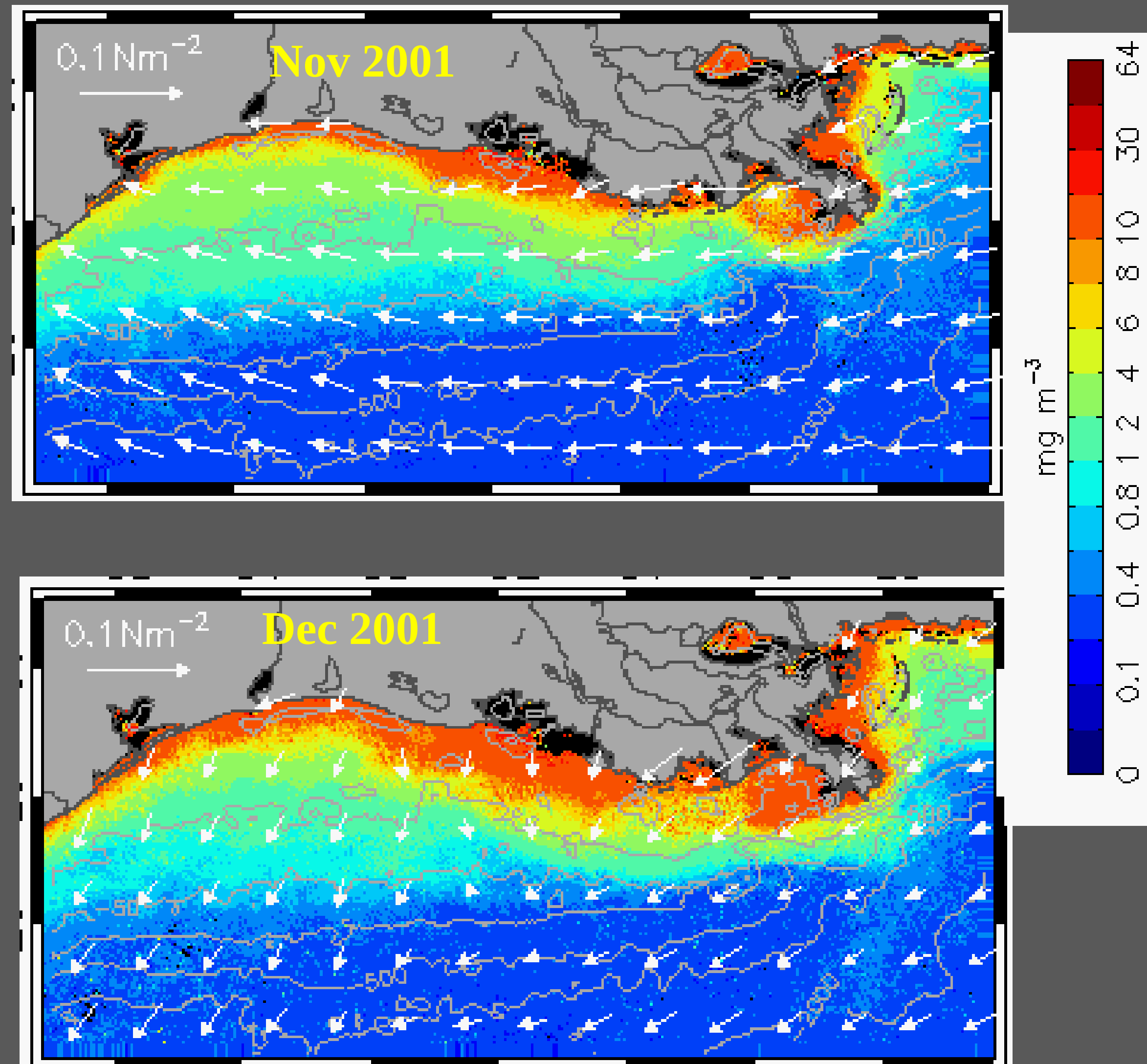


Seasonal wind patterns and Chl distribution

- Easterly winds pattern returns during fall

- Easterly winds interrupted by frequent cold fronts during winter results in net southerly wind stress and offshore dispersal of nutrient enriched coastal waters



Wavelet analysis of time series Chl (1998-2007) along bathymetric contours

•Study area was divided into zones

•Time series Chl anomalies were determined for 20 m and 100 m isobaths and Wavelet Transform (WT) applied to mean Chl anomaly data

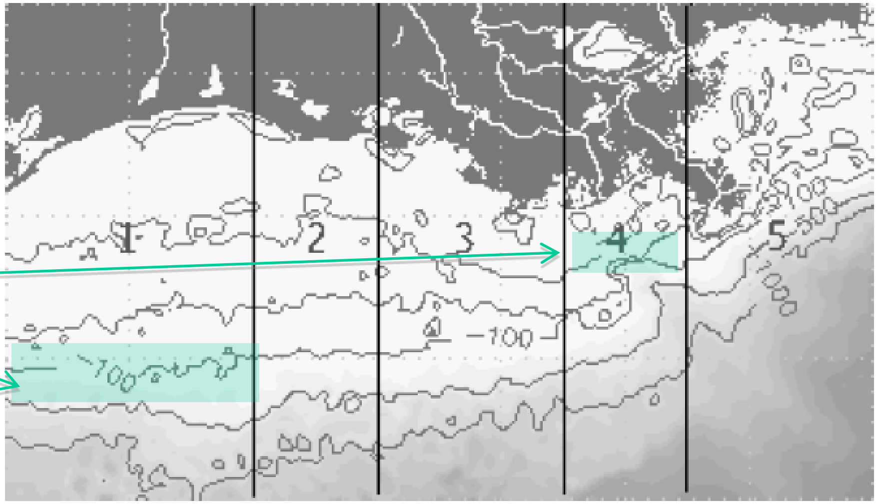


Figure 1: Map of study area.

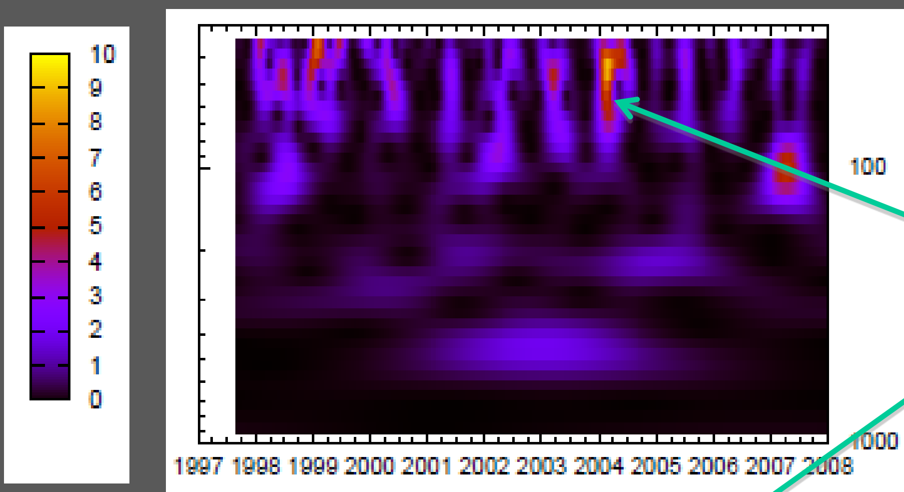
•The WT decomposes a signal into time-frequency space, quantifying not only the dominant modes of variability, but also how they vary in time

Applying the WT to the Chl time series yields the local wavelet power spectrum (original data unit squared or variance $(mg\ m^{-3})^2$

Wavelet Analysis: Time series data 1998-2007
Chl variance at 20 m isobath west of Mississippi delta

- The wavelet power and can be interpreted as a ‘map’ of the time variability of dominant frequencies (Henson and Thomas 2007)

- The scale-averaged time series (bottom figure) is the mean variance contained in a 30-100 day period band



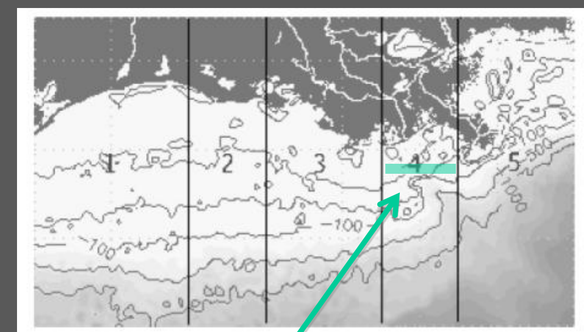
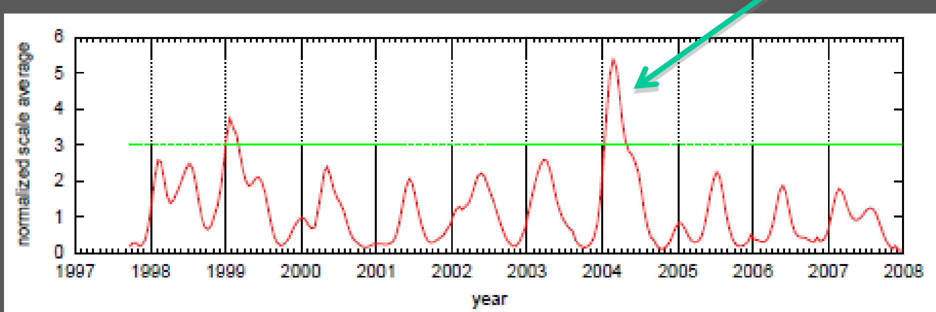


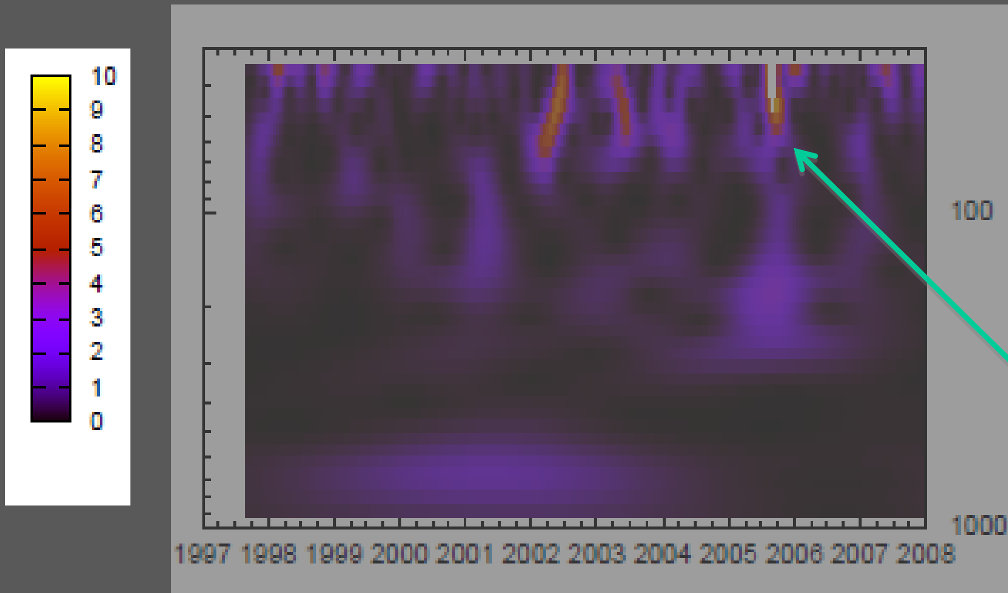
Figure 1: Map of study area.



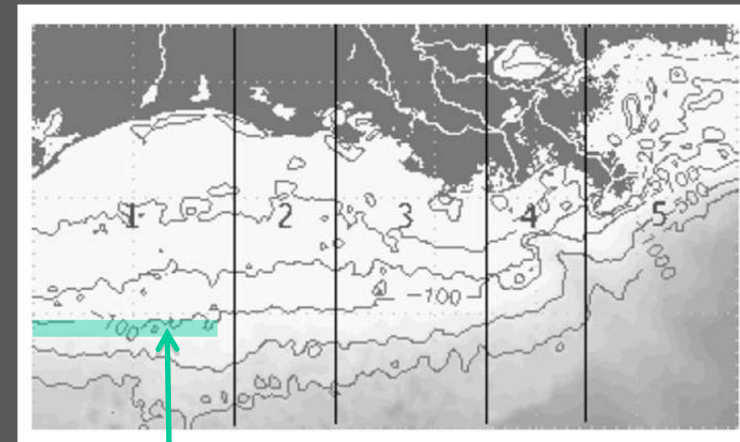
- The largest peak in wavelet power occurred in spring 2004 and a smaller peak in early 1999.

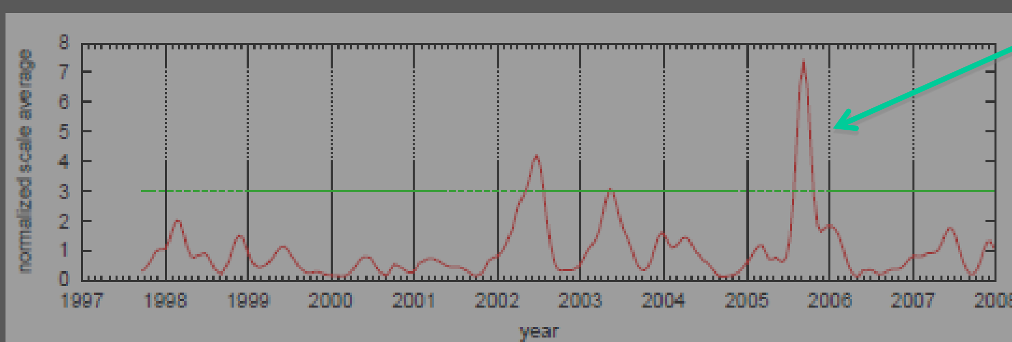
- In other years the variance was below 95% confidence interval

Chl variability west of the Atchafalaya delta – 100 m isobath



Local wavelet power spectra

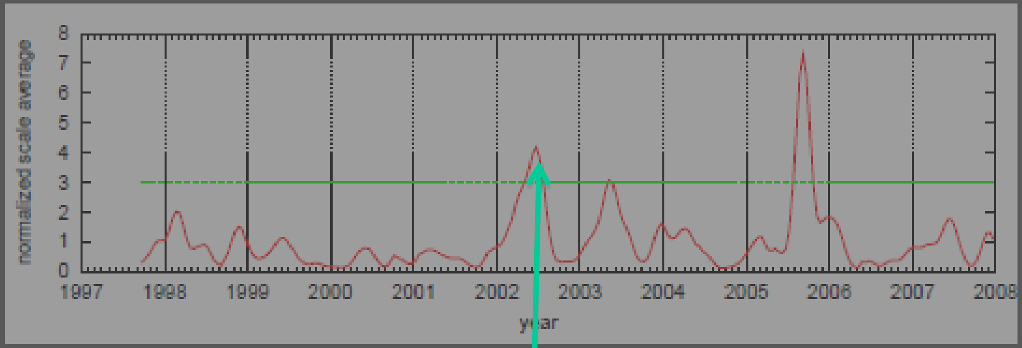


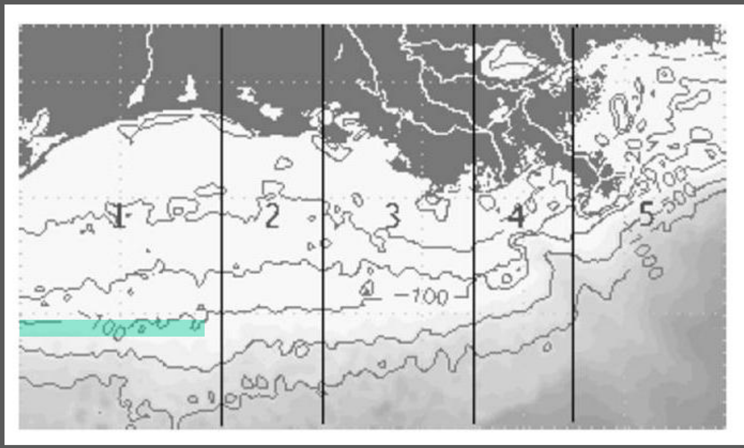


Scale-averaged time series for the period band 30-100 days

- Significant peaks in wavelet power occurred in June/July 2002 and September 2005 along 100 m isobath

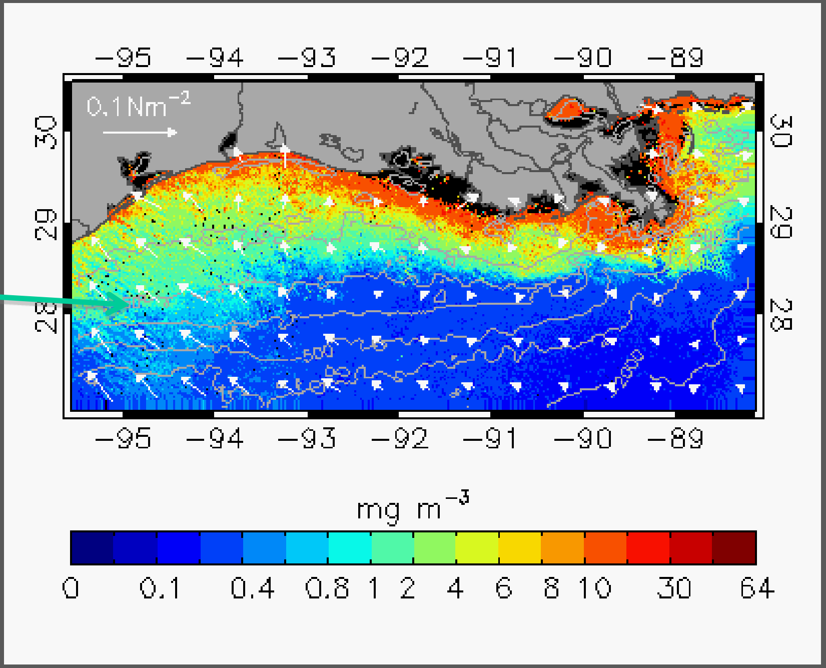
Chl variability west of the Atchafalaya delta – 100 m isobath





Scale-averaged time series for the period band 30-100 days

- Significant variance in Chl in summer of 2002 off the Texas coast



June/July 2002

Conclusions

•Combination of QuikSCAT winds and SeaWiFS chlorophyll data (processed and from Giovanni) have been used to examine short- and long-term Chl variability

•Synoptic influences of the wind field on surface Chl distributions were captured by the superimposed wind and Chl imagery

•In nearshore waters Chl was predominantly influenced by river discharge; at the offshore locations wind stress and energetic climatic events played a more significant role

•Strong seasonality in Chl spatial variability due to wind influence and river discharge

•New products in Giovanni 4 will be well suited for this type of study

References

•D’Sa, E. J., and M. Korobkin. 2009. Wind influence on chlorophyll variability along the Louisiana-Texas coast from satellite wind and ocean color data. *Proceedings SPIE*, Vol. 7473, 747305, doi:10.1117/12.830537.

•D’Sa, E. J., and M. Korobkin. 2009. Examining SeaWiFS chlorophyll variability along the Louisiana coast using wavelet analysis. *Proceedings of the Oceans 2009 MTS/IEEE Conference*, Biloxi, Mississippi, 5 pps. IEEE Catalog Number: 0-933957-38-1.

•Henson, S. and A. Thomas. 2007. Phytoplankton scales of variability in the California Current system: 1. Interannual and cross-shelf variability. *JGR Oceans*, 112, C07017.

•Walker, N. D., N. N. Rabalais. 2006. Relationships among satellite chlorophyll a, river inputs, and hypoxia on the Louisiana continental shelf, Gulf of Mexico. Estuaries and Coasts, 29, 1081-1093.

Thank You